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IN THE UNITED STATES PATENT AND TRADEMARK OFFICE  
APPLICATION FOR LETTERS PATENT

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Title : ORGANIC LIGHT EMITTING MEDIUM CONTAINING  
9,9'-BIANTHRY-10,10'-PHENANTHRCENE AND  
DEVICE CONTAINING THE MEDIUM

5 Claims

4 Sheets of Drawings

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1           **ORGANIC LIGHT EMITTING MEDIUM CONTAINING 9,9'-**  
2           **BIANTHRY-10,10'-PHENANTHRCENE AND DEVICE CONTAINING**  
3                           **THE MEDIUM**

4    BACKGROUND OF THE INVENTION

5    1. Field of the Invention

6           The present invention relates to a phenylanthracene derivative of an  
7    organic light emitting medium, and more particularly to a 9,9'-bianthry-10,10'-  
8    phenanthrcene compound that emits white light and is used in an organic light  
9    emitting device.

10   2. Description of Related Art

11           Electroluminescent devices that utilize electroluminescence have high  
12    color contrast because of the self-emission features of the electroluminescent  
13    elements and excellent impact resistance because they are completely solid  
14    devices. Therefore, electroluminescent devices have attracted attention as light  
15    emitting sources in various types of display apparatus.

16           Phenylanthracene derivatives are important light emitting materials used  
17    in electroluminescent devices and disclosed in many prior patents. In US patent  
18    No. 5635308 ('308), the phenylanthracene derivatives are in the formula:  $A_1-L-$   
19     $A_2$ , wherein  $A_1$  and  $A_2$  are a monophenylanthryl or diphenylanthryl group and L  
20    is a valence bond or a divalent linkage group. Typically, the arylenes  
21    monophenylanthryl and diphenylanthryl are novel opto-electronic functional  
22    materials. In the '308 patent, the phenylanthracene derivatives are first deposited  
23    on the organic light emitting device and are defined broadly to mainly contain  
24    derivatives containing 10,10'-phenanthrcene structure (see the abstract and claim

1 of the '308 patent).

2 US patent No. 6534199 ('199) narrowed the phenylanthracene  
3 derivative groups that emit blue light from the organic light emitting device.  
4 However, phenylanthracene derivatives emitting blue light are not widely  
5 popular since a device that can emit white light is a major objective of organic  
6 electroluminescent device development, because an organic electroluminescent  
7 device emitting white light can be used as the light source for single color  
8 displays and backlight module. Moreover, an organic device emitting white light  
9 can be used for full color display when color filters are attached to a display  
10 apparatus.

11 EP patent No. 1182244 ('244) disclosed a white organic  
12 electroluminescent element having a light emitting layer containing a light  
13 emitting material emitting blue light and a fluorescent compound (see the  
14 abstract and Fig. 1 of the '244 patent). Therefore, the light emitting material (i.e.  
15 the phenylanthracene derivative) has to mix with the fluorescent compound and  
16 cannot be used alone despite the fact that the organic electroluminescent element  
17 emits white light.

18 To overcome the shortcomings, the present invention provides a  
19 phenylanthracene derivative ,9,9'-bianthry-10,10'-phenanthrcene, applied on the  
20 organic electroluminescent element to mitigate or obviate the drawbacks of the  
21 conventional light emitting materials.

## 22 SUMMARY OF THE INVENTION

23 The first objective of the invention is to provide a 9,9'-bianthry-10,10'-  
24 phenanthrcene compound of an organic light emitting medium that emits white

1 light.

2 The second objective of the invention is to provide an  
3 electroluminescent device containing 9,9'-bianthry-10,10'-phenanthrcene served  
4 as an organic light emitting medium.

5 Other objectives, advantages and novel features of the invention will  
6 become more apparent from the following detailed description when taken in  
7 conjunction with the accompanying drawings.

#### 8 BRIEF DESCRIPTION OF THE DRAWINGS

9 Fig. 1 is an electroluminescence spectrum of example 1 of the organic  
10 electroluminescent device;

11 Fig. 2 is an electroluminescence spectrum of example 2 of the organic  
12 electroluminescent device;

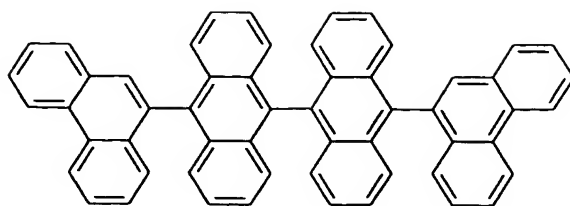
13 Fig. 3 is an electroluminescence spectrum of example 3 of the organic  
14 electroluminescent device; and

15 Fig. 4 is an electroluminescence spectrum of example 4 of the organic  
16 electroluminescent device.

#### 17 DETAILED DESCRIPTION OF PREFERRED EMBODIMENT

18 A phenylanthracene derivative in accordance with the present invention  
19 is 9, 9'-bianthry-10, 10'-phenanthrcene and has the following chemical  
20 structure:

21



An organic electroluminescent device containing 9,9'-bianthryl-10,10'-phenanthrene compound is composed of an anode, a hole-transporting layer, at least one light emitting layer, an electron-transporting layer, an electron-injection layer and a cathode. The hole-transporting layer is laminated on the anode. The at least one light emitting layer is laminated on the hole transporting layer and contains 9,9'-bianthryl-10,10'-phenanthrene. The electron-transporting layer is formed on the at least one light emitting layer. The electron-injection layer is formed on the electron-transporting layer, and the cathode is formed on the electron-injection layer.

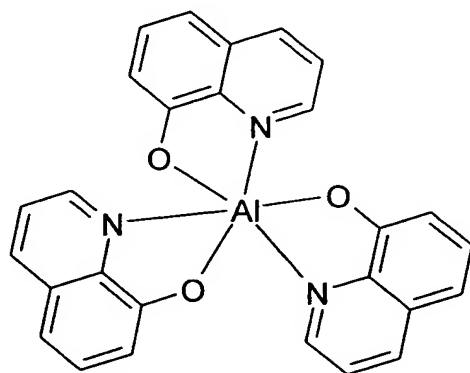
#### Synthesis of 9, 9'-bianthryl-10, 10'-phenanthrene:

5g of 10, 10'-dibromo-9,9'-bianthracene, 8.67g of 9-phenanthrylboronic acid, 3.4g of potassium fluoride, 46ml of palladium acetate, 58mg of o-(biphenyl)P(t-Bu)<sub>2</sub>, 20ml of tetrahydrofuran were sequentially placed into reacting bottle to become a mixture and thermally refluxed for 20 hours. . Then, the mixture was cooled down to room temperature and filtered to obtain impure solid. Lastly, the impure solid was further sublimated to obtained 0.4g of 9,9'-bianthryl-10,10'-phenanthrene, wherein the melting point of 9,9'-bianthryl-10,10'-phenanthrene is 558°C.

Examples of several embodiments of the organic electroluminescent device following:

Example 1:

An organic electroluminescent device has a glass substrate with an (ITO) (indium-tin-oxide) electrode with a surface resistance of 20 ohm as an anode. A 60nm organic layer was laminated on the anode by vacuum deposition of NPB (N,N'-di(1-naphthyl)-N,N'-diphenyl-[1,1'-biphenyl]-4,4'-diamine) to serve as a hole-transporting layer. A 40 nm emitting layer was formed on the hole transporting layer by vacuum deposition of 9,9'-bianthry-10,10'-phenanthrene. Then a 20 nm electron-transporting layer was formed on the emitting layer by vacuum deposition of Alq3 (aluminum tris (8-hydroxyquinolate)), wherein the Alq3 has the following chemical structure:



Additionally, a 0.8 nm electron-injection layer was deposited on the electron-transporting layer by vacuum deposition of LiF. Lastly, a 200nm aluminum cathode was formed on the electron-injection layer to achieve the organic electroluminescent device.

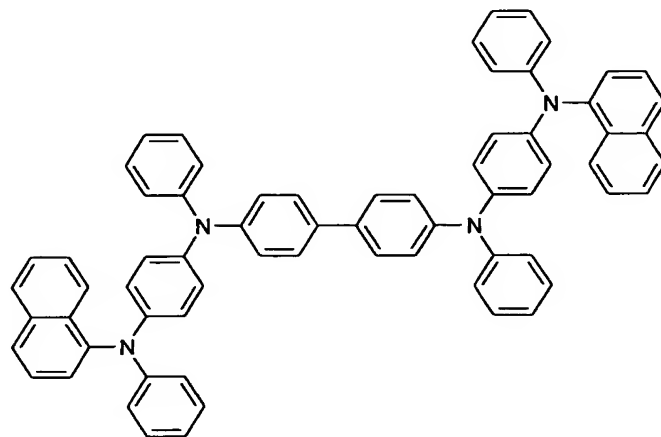
When a direct current (DC) voltage was applied to the achieved organic electroluminescence device, a yellowish white light emission with CIE

coordinate value (0.3, 0.36) was obtained. With reference to Fig. 1, the electroluminescent spectrum of the light emitted from the electroluminescent device was recorded.

#### Example 2:

An organic electroluminescent device was formed with the same ITO anode and aluminum cathode as the electroluminescent device in example 1.

A 60 nm hole-injection layer was formed on the ITO electrode by vacuum deposition of HIM(A), wherein HIM(A) has the following chemical structure:



A 30nm hole-transporting layer was laminated on the hole injection layer by vacuum deposition of NPB. Then, a 20 nm emitting layer was deposited on the hole-transporting layer by a vacuum deposition of 9,9'-bianthryl-10,10'-phenanthrene. A 20 nm electron-transporting layer was laminated on the emitting layer by vacuum deposition of Alq3. On the electron-transporting layer, a 0.8 nm electron-injection layer was formed by vacuum deposition of LiF. Lastly, a 200 nm aluminum cathode was formed by vacuum deposition on the electron-injection layer. The resultant product was an organic electroluminescent

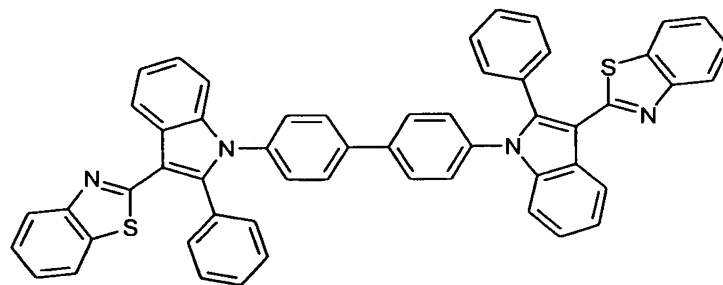
1 device.

2 When a direct current (DC) voltage was applied to the organic  
3 electroluminescent device, a yellowish white light emission with CIE 1931  
4 coordinate value (0.29, 0.34) was obtained. With reference to Fig. 2, the  
5 electroluminescent spectrum of the light emitted from the electroluminescent  
6 device was recorded.

7 Example 3:

8 An organic electroluminescent device was formed with the same ITO  
9 anode and aluminum cathode as the organic electroluminescent device in  
10 example 1.

11 A 80 nm hole-injection layer was formed on the ITO electrode by  
12 vacuum deposition of HIM(A). A 20 nm first emitting layer was formed by  
13 vacuum co-deposition of NPB and blue dopant (A), wherein the NPB is a host  
14 material and the blue dopant (A) having the following chemical structure is  
15 added to the NPB in a concentration of 5% to 10%.



17 Then, a 30 nm second emitting layer was deposited on the first emitting  
18 layer by vacuum deposition of 9,9'-bianthry-10,10'-phenanthrene. A 10 nm  
19 electron-transporting layer was formed on the second emitting layer by vacuum  
20 deposition of Alq3. A 0.8 nm electron-injection layer was deposited on the



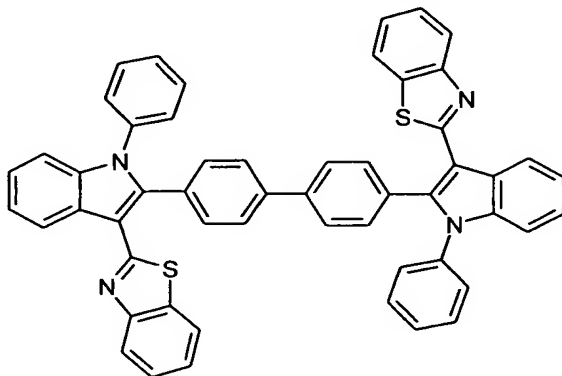
1 electron-transporting layer by vacuum deposition of LiF. Lastly, a 200 nm  
2 aluminum cathode was formed by vacuum deposition on the electron-injection  
3 layer. The resultant product was an organic electroluminescent device.

4 When a direct current (DC) voltage was applied to the organic  
5 electroluminescent device, a white light emission with CIE 1931 coordinate  
6 value (0.26, 0.32) was obtained.

7 **Example 4:**

8 An organic electroluminescent device was formed with the same ITO  
9 anode and aluminum cathode as the organic electroluminescent device in  
10 example 1.

11 A 80 nm hole-transporting layer was formed on the ITO electrode by  
12 vacuum deposition of NPB (N,N'-di(1-naphthyl)-N,N'-diphenyl-[1,1'-  
13 biphenyl]-4,4'-diamine). A 10 nm first emitting layer was formed by vacuum  
14 deposition of emitter compound (A) that has the following chemical structure.



15  
16 Then, a 30 nm second emitting layer was deposited on the first emitting  
17 layer by vacuum deposition of 9,9'-bianthry-10,10'-phenanthrene. A 10 nm  
18 electron-transporting layer was formed on the second emitting layer by vacuum  
19 deposition of Alq3. A 0.8 nm electron-injection layer was deposited on the

1 electron-transporting layer by vacuum deposition of LiF. Lastly, a 200 nm  
2 aluminum cathode was formed by vacuum deposition on the electron-injection  
3 layer. The resultant product was an organic electroluminescent device.

4       When a direct current (DC) voltage was applied to the achieved organic  
5 electroluminescent device, a white light emission with CIE 1931 coordinate  
6 value (0.29, 0.33) was obtained.

7       Based on the foregoing embodiments of organic electroluminescence  
8 devices, a phenylanthracene derivative, i.e. 9,9'-bianthry-10,10'-phenanthrene,  
9 can be used alone in a emitting layer to permit the organic electroluminescent  
10 device to emit white light.

11       Even though numerous characteristics and advantages of the present  
12 invention have been set forth in the foregoing description, together with details  
13 of the function of the invention, the disclosure is illustrative only, and changes  
14 may be made in detail, especially in matters of shape, size, and arrangement of  
15 parts within the principles of the invention to the full extent indicated by the  
16 broad general meaning of the terms in which the appended claims are expressed.